CHEMISTRY

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Miniaturization

► MINIATURIZATION is one of the clumsy new words which technical workers coin and language purists deplore. But, however awkward its form, it expresses a trend in design which is very apparent. Once a mechanism was worked by a big, heavy lever which might be the squared trunk of a whole tree. Then the lever grew thinner but more efficient as the makers learned to discard weight where it is not needed and to design for strength. Substitution of metal for wood brought a new kind of machine because the strength of the metal allowed the working parts to be made much smaller.

When electric power took over many tasks which only steam engines could have done earlier, shafting and pulleys were replaced in large part by finer and more direct methods of transmitting and regulating the motion derived from the engine. For many purposes a huge, centralized power plant could be replaced by a tiny, portable electric motor. The development of motors themselves has produced smaller and smaller ones, until now, for special purposes, giants of strength have been built in toy-like proportions.

In the rapidly developing electronics industry, vacuum tubes are growing smaller and smaller, but even so they are being crowded out by pea-sized transistors which depend for their operation on minute variations in atomic structure. The batteries which operate many electric and electronic devices are also shrinking. Now comes the combination of battery and transistor principle which offers electricity directly from atomic disintegration.

Crystals play a very important part in the new understanding of how to get wanted effects from the properties of matter. Crystals which vibrate to tell time, for example, take the place of delicate spring and escapement mechanisms. These, in watches, have themselves been reduced to very slight proportions compared with the pendulums and weights of the "grandfather clocks." Scientists hope that designs using smaller crystals will evolve from present research. Smaller quartz crystals should be sturdier, less susceptible to temperature change and mechanical accidents. Old clocks ticked seconds. Crystal clocks vibrate around a hundred thousand times as fast. And the rate for smaller crystals? "We think about five million might be practical," the physicists say.

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Consulting Editor: PAULINE BEERY MACK (Editor 1927-1944)

▶ LARGEST *man-made crystal of pure quartz, weighing 1014 grams, nearly 2¼ pounds, is claimed by Brush Laboratories Co. of Cleveland, Ohio. Careful tests by the Signal Corps, sponsor of this crystal-growing project, have shown that such synthetic quartz crystals are satisfactory for use in all frequency control applications for which natural quartz is now used.*

Time-Telling Crystals

by HELEN M. DAVIS

▶ JEWELS of the present day have work to do. It is no longer enough for them to be sparkling and glamorous. Today they tell time, regulate radio and TV circuits and report upon the ultimate structure of matter.

Once jewels were a sort of super coinage. A traveller would carry the bulk of the money for his journey in gems, possibly sewed into the lining of his clothes. When he became short of cash he would sell one or another of the rare hard minerals of his collection. The jeweller's experience in assaying the quality of the stone corresponded, in that day, to international currency ratings in our time.

Clear, transparent crystals, free from flaws, are still held in high regard. One reason is because they are so rare. But scientists have learned the secret of making clear flawless crystals, and, for certain purposes, can make better ones than are found in nature.

The quartz crystals for electronic circuits can now be man-made with great purity of structure. The skill is new. Although it has been known for a long time that quartz is silicon dioxide, a crystallized form of sand, and although man has made glass out of sand since the early Egyptian dynasties, the knack of getting quartz crystals out of a furnace has been mastered only in our own day.

Techniques for growing quartz crystals artificially sprang from research on growing salt crystals for various electronic devices during World War II. Bell Telephone Laboratories of Murray Hill, N.J., and Brush Development Co. of Cleveland, Ohio, were leaders in this research. After the war, information on German attempts to grow quartz crystals from alkaline solution under conditions of high temperature and pressure came to the attention of these laboratories, and they began work on the problem.

Their success is shown by the size and clarity of the crystals they are now able to produce. The clarity demanded of this work means not only freedom from optical defects but also freedom from "twin" structure which would distort the electrical effects demanded of today's working crystals.

Very fine natural quartz imported from Brazil furnishes the crystals which are depended upon for high precision instruments today. But there is a very good chance, in the opinion of electronics experts, that artificially cultured quartz crystals may be even more perfect.

Temperature, pressure and concentration of chemicals in solution are the three essentials to watch in any work with materials. Scientists now know how to regulate these exactly. When the Brush Laboratories of Cleveland, Ohio, wanted to grow a large quartz crystal, lately, for the U. S. Signal Corps, they set the temperature control at 660° F. and compressed the material in an autoclave at a pressure of 5000 lbs. per square inch. Water containing 18% sodium carbonate (common washing soda) was the medium for growing the crystal.

The record-breaking crystal which they produced weighed 1014 grams, (over two pounds) and was unusually clear. It was grown on a natural quartz seed plate less than one-twentieth its size, and took 78 days to reach its final dimensions.

Crystals are built up atom by atom. It is the nature of most inorganic chemical substances to assemble in these characteristic regular forms. Whenever conditions are such that atoms are free to move and no barriers interfere, crystals tend to form. Not only that, but imperfect crystals, whose growth has been hindered by such interference, when put back into a liquid like that in which they were formed, tend to mend themselves. Rough edges dissolve, imperfections are smoothed out by deposit of new material from the solution.

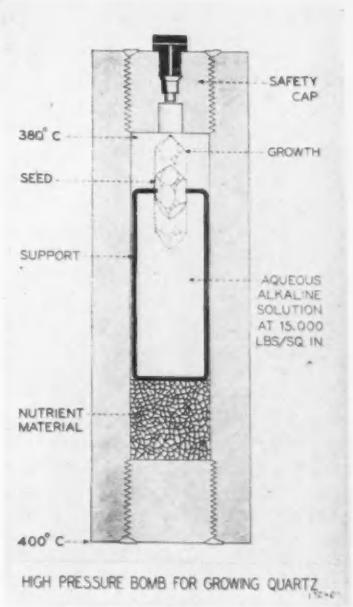
When a solution is holding just a

little bit more of a salt or other chemical than is in equilibrium, there is a strong tendency for the solid material to crystallize out. A disturbance, such as a slight jolt, will start the process. A tiny dust particle may serve as a nucleus around which a crystal will begin to form.

When a scientist wants to grow a large, perfect crystal, he provides what he calls a "seed crystal" to start the process. He selects a small but perfect sample of the kind of crystal he wants, and inserts it into the solution. As atoms from the solution crystallize out, under conditions where the process can go on slowly and quietly, this seed crystal is built up by regular additions on all the faces bathed by the solution. If the crystal lies on the bottom of the dish, the upper half usually grows to the perfect form, while it is immersed in the liquid. The part resting on the dish remains flat or shows distortion. Apparatus for growing large crystals, therefore, usually has some means for suspending the seed crystal in the center of the solution, touched by as little extraneous material as possible.

Scientific interest in large crystals stems from several sources. One is the theoretical and obvious interest of working with homogeneous chunks of pure matter. Another is very practical, and more surprising. This has to do with keeping broadcasting stations on the beam, and telling time.

At first sight, a bit of glassy nonconducting material introduced into an electrical circuit would seem as irrational as the "magic" ascribed to crystals in the middle ages. But crystals have properties that are stranger than magic.



➤ Diagram *of section through the bomb used to grow quartz crystals.*

One of these strange properties was investigated by Pierre Curie and his brother, before the days of radium. It is called the "piezo-electric effect." The investigation was the purest kind of "pure research," for nobody could then have imagined what use could be made of it.

The effect is a very slight evidence of electricity when a quartz crystal is pinched in a particular way. Small bits of paper will cling to the electrified surface. The gold-foil leaves of an electroscope will fall or rise, showing the kind of charge induced on the crystal.

Not every crystal will give the piezo electric effect. The reason quartz is favored is that it is hard, stable and insoluble, as well as lop-sided. The last quality is the most important. It is amazing what a lop-sided crystal can do.

Crystals grow in essentially simple geometrical forms, such as the cube, the pyramid and the prism. In cross-section, these forms are either hexagonal, like snowflakes, or four-sided figures, variously distorted.

When the solid crystal is unsymmetrical, opposite corners are often missing. This is the case with quartz crystals. When the form of such a crystal is complete, the quartz is in the shape of a prism with two ends which are modified pyramids. When held with the peaks of the pyramids pointing up-and-down, the left-hand corners seem to be cut off as though by planes which would, if extended, enclosed the prism with two triangular pyramids. Lines passing through these imaginary pyramids give the direction in which the electrical effect is produced.

A quartz crystal when heated will acquire opposite electric charges, plus or minus, at the ends of these "electric axes." When it is cooled, these electric poles change sign. Placed in a vise and squeezed, the difference in electric charge appears similarly. Released, the polarity is reversed. This is a piezo-electric crystal, as studied by the Curie brothers. They found a number of laboratory chemicals and naturally occurring minerals which show this effect. They experimented with the minerals blende, boracite, tourmaline, quartz, calamine and topaz, and chemicals such as sodium chlorate, sugar, potassium sodium tartrate, and tartaric acid with right-hand symmetry.

Although remaining a laboratory curiosity for half a century, the phenomenon of piezo-electricity was not neglected. Inquisitive scientists poked and pulled at the lop-sided crystals, and the laws under which they operate were well worked out.

It was soon discovered that the phenomenon worked also in reverse. Treat the crystal with mechanical energy, by squeezing it, and electrical energy appears. Apply electrical energy to the crystal and it will respond by expanding and contracting in rhythmical vibration, an output of mechanical energy again.

It is a characteristic of rhythmic vibration that its rate depends on the dimensions of the material but that its motion is independent of time. The regular swing of the cathedral lamp, which Galileo timed by his pulse, led that early scientist to invent the pendulum clock. The vibration of a tuned violin string or of the air column in an organ pipe gives a standard musical note, the result of a definite rate of vibration. In just the same way, the vibration of a quartz crystal which is "driven" by the electric impulses applied to its electric axis can be used to tell time.

An odd thing about vibrations is that anything which is free to oscillate will move according to its characteristic period of vibration. As musicians learned long ago, and physicists more recently, the motion of the object as a whole produces the deepest note, and, along with this tone, are produced ghostly overtones, or harmonics, which are characteristic of

▶ BIPYRAMID *form of a quartz crystal grown at Bell Telephone Laboratories from an irregular piece of Brazillian quartz with no natural crystal faces. Extended experiments have proved the secret of growing large and perfectly formed crystals.*

halves, quarters and other simple fractions of the length of the vibrating string, air column or other oscillating substance. This kind of motion is produced whenever there is regular vibration, although only certain kinds and sizes of vibration can be heard.

Conversely, strings, air columns and other things free to vibrate can be set in motion by waves. Caruso is said to have shattered a thin glass tumbler by singing its fundamental note. An army is said to have set a suspension bridge into dangerous vibration because its measured tread was a harmonic of the bridge's natural vibration period.

Because the waves which are the harmonics of a natural vibration period are simple sub-multiples of the total length, there is a very strong tendency for a rigid vibrating substance to affect nearby vibrations of more flexible materials of nearly the same vibration period as the fundamental note or one of the harmonics.

Well known from sound vibrations, this principle of resonance was taken over by physicists and its use adapted to electronic waves.

An early application of the vibration of a quartz crystal was to make it regulate the constancy of radio transmission. Then it was used to monitor astronomical clocks.

Tuned electronic circuits have a tendency to oscillate around the frequency for which they are designed. Physicists describe this wavering as "hunting." A properly cut piece of quartz crystal in the circuit reduces the hunting markedly. This reduces interference between stations, and therefore allows better use of radio channels.

Employment of crystals in radio circuits has been commonplace ever since the use of galena crystals, with their "sensitive spots," as detectors in the early crystal set receivers.

Modern phono-pickup circuits often use a salt crystal. This is Rochelle salt, potassium sodium tartrate, one of the substances studied by the Curie brothers.

Employment of crystals to tell time is a newer development.

Anything which repeats a simple harmonic motion regularly can be used as a clock. The important thing is that its rate be regular. The scale which shows this regularity, whether it is a dial with hands or a "pip" on a continuously drawn line, can easily be hooked onto the vibrating mechanism. The crystal clock uses the steady rhythm of the "driven" crystal to obtain the necessary vibration. An oscillating radio circuit is then built to vibrate at an exact sub-multiple of the crystal's rate, or a multi-frequency circuit is built, one of whose harmonics has this property. When reduced to the proper level, the electronic circuit is then connected to a synchronous electric motor, and from this motor gear trains can run clocks, chronographs, or whatever device is needed. For astronomical work the same circuit can be made to show both sidereal time, by which astronomers reckon, and mean sun time, by which work-day hours are regulated.

The rate of vibration of the quartz crystal is of the order of a hundred thousand vibrations per second. A circuit in resonance with it might vibrate at 10,000 vibrations. A second reduction, obtained from the next circuit, might vibrate at the rate of 1,000, and

this might be used to drive the synchronous motor.

The problem of how to keep the clock from stopping is met by using vibrating crystals in groups of three, so that if one stops the others will probably keep going. Quartz crystals are very sturdy, but after long service one will sometimes crack. It has been pointed out that a quartz crystal makes as many complete vibrations in five minutes as an ordinary clock pendulum makes in two years.

One drawback to more widespread use of crystal clocks is the fact that those now in use have to be kept at constant temperature. This is no novelty to the scientists who keep the nation's official time. The master clocks of the National Bureau of Standards and the Naval Observatory have been protected against the effects of temperature changes, both when they were driven by vibrations of a pendulum and now when they are driven by vibrations of a crystal.

The development in which companies manufacturing timepieces for you and me are interested lies in the direction of smaller crystals. Small crystals will stand shock from handling and from temperature change better than large ones. Therefore the manufacturers hope for some that will be sturdy enough for ordinary wear and tear. Perhaps grown-to-order crystals will be developed to meet this need. Physicists calculate that crystals small enough to be satisfactory will vibrate much faster than those now in use in the standard clocks. Since the vibration rate goes up as the size becomes smaller, the crystal clock of the future may have a rate as high as 5 million vibrations per second.

The crystal, which began by monitoring other timepieces, has proved so much more accurate that it has taken over the main job. With its aid, irregularities never before apparent in the earth's motion have been measured. They have been accounted for as the effect of braking action due to the tides. Their effect has been projected into the far distant future, when the earth and the moon will never turn their faces away from each other. All this from a lop-sided crystal!

On the Back Cover

➤ QUARTZ *crystals growing in a bomb. Carefully aligned for proper development of their electric axes, these man-made crystals may regulate radio circuits or even pace the circuit of the earth around the sun.*

Antibiotics Unique In Chemical Build

Antibiotics Spur New Research

➤ THE ANTIBIOTICS, so-called mold remedies, are as wonderful in their chemistry as they are in their disease-curing powers, Prof. Donald J. Cram of the University of California at Los Angeles declared at a recent sectional meeting of the American Chemical Society.

Each of them, he said, has some peculiar arrangement of atoms which has not previously appeared in natural compounds.

In fact, the organic chemists were so unwilling to believe a natural, instead of man-made, chemical could have an arrangement of atoms called a "four-membered lactam ring" that research on the structure of penicillin was frustrated for well over a year, in spite of unprecedented efforts to elucidate it.

The discovery and investigation of the antibiotics gave a healthy boost, not only to the treatment of disease, but also to the field of organic chemistry, Dr. Cram declared. The novel discoveries and the violation of preconceived ideas connected with research on the antibiotics have influenced related fields of chemistry and imbued scientific investigators with greater freedom of imagination in their work, it was stated. Whole new fields of research have been opened up in the study of such products as fungicides and wood preservatives and in such academic problems as how molecules are built and how they react toward each other.

A tremendous stride in making cortisone more readily available was made when it was found that certain families of molds could carry out a chemical transformation in one step which by ordinary chemical reactions involved eight to sixteen steps. It would appear to be only a matter of time before the capabilities of the molds and allied micro-organisms are found to include many more substitutes for ordinary organic synthetic procedures.

Six New Antibiotics

➤ HALF a dozen new antibiotics for fighting infectious diseases and one anti-tumor antibiotic were reported at a symposium held under the sponsorship of the Food and Drug Administration of the U. S. Department of Health, Education and Welfare.

The six new ones are Tetracycline, Hygromycin, Streptogramin, Ruticin, Streptocardin and Methymycin.

The potential anti-tumor antibiotic is Puromycin. Its effect on experimental tumors was reported.

While these new antibiotics, or so-called mold remedies, hold the spotlight, results with some of the older ones, best methods of using them and ways of avoiding their disadvantages such as sensitivity of the patient and resistance of the germs were described.

Ten years ago penicillin was the only antibiotic known to medical practice, and its use was confined to battlefield casualties, Dr. Henry Welch, chief of the Food and Drug Administration's antibiotic division, pointed out.

There was none available for civilian patients. Today there are numerous antibiotics, accounting for more than one-half of all prescriptions written in this country.

The past ten years may well go down in medical history as the "Antibiotic Era," based upon what these drugs have done to minimize human suffering and extend the life span.

Primary syphilis has been markedly reduced throughout the United States, to the point where it has become very difficult to find cases for clinical study. Marked progress is being made in the eradication of spirochetal diseases in tropical countries where these diseases are endemic. Mass therapy measures under the auspices of the WHO should eventually wipe them out.

The fatality rate for pneumococcic pneumonia has been cut to an all-time low of less than 5%. Prior to the introduction of serums it ran from 20% to 30%. The serum cut it to 15%, the sulfonamides to around 10%, and penicillin to less than 5%.

Subacute bacterial encodaritis was practically 100% fatal before antibiotics, but today over 50% are saved.

Operations for acute mastoiditis are almost a thing of the past. A few dollars' worth of antibiotic usually prevents or cures these troublesome infections.

These are only a few outstanding examples of the contributions to health made by the antibiotic drugs. Today we are seeing the development of an important economic contribution through the use of antibiotics for promoting healthy, rapid growth of swine and poultry. In the feeding of chickens the time from hatching to marketing may be cut as much as four weeks by use of antibiotic-treated feedstuffs. This saving is increased by reduction of losses from disease as well as more rapid growth, savings in feed, and more rapid marketing.

It would be unrealistic to say that the antibiotics have not also brought their problems.

The answers to these problems lie in continued research by competent investigators and in the proper use of these drugs under supervision of the medical profession.

Flu Viruses in Mice

➤ AN ANTIBIOTIC drug that can stop two human influenza viruses in mice was announced by Drs. D. A. Harris, H. B. Woodruff and Laurella McClelland of Merck and Co. Research Laboratories, Rahway, N. J., at the antibiotic symposium.

The new antibiotic has been obtained in crystalline form from an organism called *Nocardia formica.*

Besides its "favorable" effect on mice infected with the human 'flu viruses, it enabled mice infected with swine influenza virus to survive twice as long as infected, untreated mice.

It also delays the development of mumps virus in eggs.

Controls Fungus Diseases

➤ OLIGOMYCIN, a new antibiotic isolated at the University of Wisconsin, shows promise in the control of plant fungus diseases.

The antibiotic was discovered by Bacteriologists Elizabeth McCoy, W. H. Peterson and Robert M. Smith.

Unlike streptomycin, terramycin and other antibiotics which are effective only against bacteria, oligomycin strikes at many plant disease fungi and at the same time is harmless to bacteria. At the present time use of antibiotics to fight bacterial diseases in animals and plants is rapidly expanding.

Scientists have searched for a way to control fungus diseases without harming helpful bacteria in the plant and injuring the plant itself. Spray fungicides used now will control fungus diseases, but the spray also damages the plant. An antibiotic which is selective in its action against fungi has been sought for use against these expensive and hard-to-treat plant diseases.

Tests seem to indicate that oligomycin is the answer to this search. The tests will be continued, however, to determine other aspects of oligomycin's action in plants.

The new antibiotic has another property not shared by other members of the "wonder drug" family. It is highly stable when used against plant diseases in the soil. Streptomycin and other antibiotics lose their potency very quickly when applied to the soil. Oligomycin maintains its activity over a wide range of acidity and temperature conditions.

Make Silkworms Grow, Too

➤ Some of the antibiotics, so-called mold remedies for germ diseases, can make silkworms grow faster, just as they speed growth of cattle, chickens, pigs and other mammals.

But the faster-growing worms produce less silk. Silk production can be speeded along with growth, however, if enough extra nitrogen from a high quality source, such as the milk protein, casein, is fed with the antibiotic.

Experiments showing this are reported by Drs. M. R. Venkatachala Murthy and M. Sreenivasaya of the Indian Institute of Science, Bangalore, in the scientific journal, *Nature*.

Aureomycin and chloromycetin, they found, stimulate silkworm growth but terramycin, either alone or with amino-acid mixtures to supply nitrogen, did not show any effect on growth or silk production.

Red-Blood Material in Protozoa

➤ Red blood material has been discovered in very primitive animals, protozoa.

Hemoglobin may be much more widely distributed in this large phyla division of the animal kingdom, Drs. D. Keilin and J. F. Ryley of Cambridge University's Molteno Institute suggest in a report to the British scientific journal, *Nature*.

They proved spectroscopically that this iron-containing constituent so important in human blood exists in small quantities in *Tetrahymena pyriformis*. In 1937 two Japanese scientists, T. Sato and H. Tamiya, found it in *Paramecium caudatum*.

Way Life Is Handed On
Seems Near Discovery

Chemical Essence of Life

by Watson Davis

➤ One of the fundamental problems of living matter is the way life is handed on, that is, how the molecules that carry on heredity are duplicated within the cells. It seems to be near solution through a new chemical structure proposed for the substance that is most essential in the dividing cells involved in life of all varieties.

This sort of "chemical essence of life" is DNA, the full name of which is deoxyribonucleic acid. Its importance within living cells is today undisputed. The stature of this chemical has grown in the past year or two.

A suggested structure for this chemical, telling how the molecules that compose it are put together, is creating about as much interest and hopeful speculation in chemistry and biology as anything that has happened in many months.

For the mystery being solved is not alone how the stream of life of human beings, animals, plants and all other living things is carried on. It involves the multiplication of all cells and units of living matter. It is therefore basic to disease, such as cancer, which is unruly multiplication of cells. It may tell how unconquered viruses, recently photographed with the electron microscope, proliferate, which should be a step toward keeping them in hand.

DNA's architects are two scientists working in the famous Cavendish Laboratory at Cambridge University, England, where so many important discoveries have been made over the decades. One of them is Dr. J. D. Watson who has been working on a fellowship from the National Foundation for Infantile Paralysis supported by the March of Dimes in the United States. The other is Dr. F. H. C. Crick who has collaborated on the mathematical theory that protein molecules are wound into the shape of a helix or coiled spring. These two scientists are a part of Britain's Medical Council unit for the study of the molecular structure of biological systems.

They have succeeded in working out a manner of construction of DNA that suggests how it can accomplish an exact duplication of itself.

This is something new. It may solve a major puzzle. DNA is found in all dividing cells, largely if not entirely in the nucleus. It is an essential constituent of the chromosomes, the parts of the cell in which the stuff of heredity is located. Many lines of evidence indicate that DNA is the carrier of a part, if not all, of the genetic specificity of the chromosomes. Thus it is the chemical of the genes, the actual transmitting agent of all characteristics of the parents to their offspring. It is one of the world's most important substances.

DNA appears in some of the literature as desoxyribonucleic acid. In 1953, by international agreement,

chemists decided to write it deoxyribonucleic acid.

Far too minute to be ever seen with the most powerful microscopes, X-ray crystal studies give evidence to support the theoretical and mathematical ideas suggested.

The DNA molecule is a long chain. Its backbone consists of a regular alternation of sugar and phosphate groups. To each sugar is attached irregularly a nitrogenous base, which can be of four different types, two of which are purines, called adenine and guanine, and the others are pyrimidines, called thymine and cytosine. The unit consisting of phosphate, sugar and base is called a nucleotide.

The structure has two chains both coiled around a common axis of the fiber. These two chains are held together by hydrogen bonds between the bases, and the bases are joined together in pairs. One member of the pair must be a purine and the other a pyrimidine in order to bridge between the two chains.

Any sequence of pairs of the bases can fit into the structure and in a long molecule many different permutations are possible. The Cavendish Laboratory scientists suggest that the precise sequence of the bases is the code which carries the genetical information.

One of the chains is the complement of the other. This feature suggests how the DNA molecule might duplicate itself.

In the process of duplication it is visualized that the two chains unwind and separate. Each chain then acts as the model or template for the formation on itself of a new companion chain. There are two pairs of chains where there was only one pair before. There has been exact duplication, carrying the qualities of the original structure.

Enthusiastically, the scientists speculate on just how much these supposed happenings can explain. The unusual changes in heredity—are they due to one of the bases occasionally occurring in a less likely form? What makes the pairs of chains unwind and separate? What is the chemical origin of the stuff of the crystal?

This discussion is part of the great and inspiring push toward understanding the complexities of the materials of life. Dr. Linus Pauling and Dr. Robert B. Corey of the California Institute of Technology are solving the related problems of the structure of individual kinds of protein materials. The researches and the ideas of one group aid those of another. Almost every issue of leading scientific journals adds new facts and theories. The most important chemicals of life are being better understood and man reaches for the very mystery of life.

Latest advance in wide temperature range greases under development is a copper phthalocyanine lubricant with use range now good from minus 80 to plus 400 degrees Fahrenheit.

To make the world's largest telescope, now installed atop of Mount Palomar, 5¼ tons of glass had to be ground away from the 200-inch lens.

Oxytocin Duplicated
Vasopressin Studied

Pituitary Hormone Synthesized

➤ SYNTHESIS for the first time of a hormone from the pituitary, often called the body's master gland and famous as source of anti-arthritis ACTH, was recently announced by Dr. Vincent du Vigneaud and associates of Cornell University Medical College at the New York Hospital-Cornell Medical Center, New York City.

Synthesis of a second hormone from this same gland has almost been accomplished, Dr. du Vigneaud reported at the same time.

The first hormone is oxytocin, important in childbirth and lactation. The second is vasopressin, the blood pressure raising and antidiuretic hormone of the pituitary.

Associated with Dr. du Vigneaud in synthesis of oxytocin were Drs. Charlotte Ressler, John M. Swan, Carleton W. Roberts, Panayotis G. Katsoyannis and Samuel Gordon.

Working with him on vasopressin were Miss H. Claire Lawler and Dr. Edwin A. Popenoe.

Details of the synthesis of oxytocin and the chemical structure of vasopressin with signs of success in its synthesis were reported by the Cornell researchers in the *Journal of the American Chemical Society*.

Oxytocin gets its name from the Greek word for "rapid birth." Its effect in causing contractions of the uterus make it important in childbirth, while it also influences release of milk in the mammary glands.

The achievement of the synthesis of oxytocin establishes the structure of this hormone and opens the door to many new investigations in biochemistry, pharmacology and physiology, which should lead to a better understanding of the function of this important principle, Dr. du Vigneaud pointed out. Such a synthesis may also provide an unlimited source of the oxytocic hormone for possible expansion of its use in clinical medicine, particularly in obstetrics, and in veterinary medicine.

Tests of synthetic oxytocin, by Dr. R. Gordon Douglas, Dr. Kenneth G. Nickerson and Prof. Roy W. Bonsnes of the department of obstetrics and gynecology showed it fully effective in stimulating labor in humans. It also possessed milk-releasing activity. About one-millionth of a gram of either the natural or synthetic material injected into a woman's veins induced milk release in 20 to 30 seconds.

Oxytocin is a polypeptide, the first polypeptide hormone to be made synthetically. It is made up of eight amino acids: leucine, isoleucine, proline, tyrosine, glutamic acid, aspartic acid, glycine and cystine. It also contains three molecules of ammonia. Five of the amino acids are in a ring-like structure with three in a chain at the side. The two sulfur atoms of cystine are in the ring.

Vasopressin is believed to have a similar structure. It is made of eight amino acids and three molecules of ammonia. Six of the amino acids are the same as those in oxytocin, but the leucine and isoleucine are replaced by phenylalanine and arginine.

Oxytocin from hog glands appeared to be the same as that from beef glands, but a surprise was encountered with vasopressin. Dr. Popenoe, Miss Lawler, and Dr. du Vigneaud found that hog vasopressin contained lysine in place of arginine. This may be of far-reaching significance and the hormones from other species are being investigated, Dr. du Vigneaud said.

Water Shortage Due to Use

➤ THE NATION'S water shortage is largely due to greatly increased use and not to a general drop in water resources. Carl G. Paulsen, chief hydraulic engineer, U. S. Geological Survey, Washington, D. C., told the National Reclamation Association at a recent meeting that there is no evidence of a general decline in water resources.

In the long run, he said, we must face the reality that water resources remain practically constant, whereas the use continues to increase. Therefore, there must come a day when there will not be enough water for all the things we want to do with it.

The report on national water resources with particular emphasis on the drought-stricken areas of the West was prepared by Mr. Paulsen and A. Nelson Sayre, chief, ground water branch, Geological Survey. Since the early days of westward expansion, engineers have warned that the increasing population and farm acreage would face water shortages. The great drought of the 1890's proved that rain does not follow the plow, and this lesson was reinforced by water shortages during the 1930's which created the Dust Bowl. Periods of abundant water and drought seem to alternate, and Mr. Paulsen pointed out that the nation was fortunate that World War II came during a period of abundant water.

In addition to the well known plight of farmers and some towns and cities in drought periods, industries are becoming increasingly worried about their water supplies. Industries in Pennsylvania alone used 10 billion gallons of water daily in 1951 or about two-thirds as much water as the total daily output of all the municipal water systems in the United States.

The nation's first need in the area of water resources, Mr. Paulsen said, is a survey to determine the "location, amount and quality of water resources" throughout the nation area by area.

After such a survey has been made, the hydraulic engineer suggested that scientists could work out means of more efficient utilization of water and the possible artificial recharge of some ground water supplies.

Too Many Electrons Showering Down on Us

Nuclear Reactions in the Heavens

➤ TOO MANY electrons are showering down on us. At least there are too many of these tiny units of electrical charge to be explained by present theories, which hold that electrons are produced by cosmic rays smashing into the atmosphere high above the earth.

"Unknown particles or processes" must be involved, Prof. Kurt Sitte of the Syracuse University, Syracuse, N. Y., says. His conclusion is based on studies made this past summer at altitudes of 10,000 to 14,000 feet in Colorado.

Dr. Sitte left in October for a visiting professorship at the University of Sao Paulo in Brazil. From January to March, 1954, at Chacaltaya, Bolivia, 18,000 feet above sea level, he plans to try to find out just what particles or processes produce the electrons that cannot be accounted for by present theories.

Probing Stellar Reactions

➤A NEW method for figuring here on earth what goes on at the extremely high temperatures found in the sun and other stars was revealed to members of the National Academy of Sciences meeting by Dr. I. Amdur of the Massachusetts Institute of Technology.

His method consists, not in trying to duplicate in the laboratory temperatures of the order of thousands of degrees, but in obtaining basic information concerning the properties of gases by scattering beams of neutral particles with energies of 200 to 2,000 volts. The neutral-particle beam is scattered in a gas in much the same way that a flashlight beam is dispersed when it is shined into a murky solution. From the way the neutral particle beam is scattered, Dr. Amdur can calculate the desired gas properties.

Information on these properties can aid astronomers who are trying to find out if the universe is in a state of continual "creation," that is, with new stars being born out of cosmic dust all the time, since such cosmic dust is composed of gas particles. Dr. Amdur's data can also be used in calculating the rate at which the sun and other stars radiate energy into surrounding space.

Radiation Dominated

➤ IN THE BEGINNING of our expanding universe, there was much more light, heat and other radiation. There was less matter in the universe when it was born about five million years ago and during its first quarter billion years.

With the aid of Einstein's theories, his mass-energy equivalence, universe theory, and measures of the age of the earth and stars, Prof. George Gamow of George Washington University was able to tell the National Academy of Sciences meeting that there was a time when radiation governed the universe. Now the equivalent mass of

radiation is considered negligible compared with the mass of the atoms of matter.

He has figured out when the matter in the universe became predominant. It was just about 4,740,000,000 years ago when the universe was 260,000,000 years old.

A-Bomb Debris Element

➤ AN ELEMENT that is unknown on earth except when made by atomic bombardment as in the A-bomb exists in large quantity in some giant stars.

A new theory of how technetium, element 43, once a mere hole in the chemical table of elements, is created in the stars by thermonuclear reactions was presented to the American Physical Society meeting by Dr. A. G. W. Cameron of Iowa State College.

Thermonuclear reactions are the sort that are involved in the H-bomb, in which the lighter elements are fused with loss of matter that is converted into energy. When hydrogen which fuels such a reaction is exhausted in a giant star, the core is expected to contract and the central temperature would rise until thermonuclear reactions with helium begin. When the temperature reaches approximately 100,000,000 degrees on the absolute scale, in Dr. Cameron's theory, a kind of heavy carbon, atomic weight 13, when bombarded with an alpha particle or helium atom, would create an oxygen atom of the ordinary sort, weight 16, and give off a neutron.

The plentiful supply of neutrons thus generated would be captured by heavier elements that are in the star and change them into the kinds of elements that the spectra of light from the stars show to be present. Among the elements formed in this way would be technetium, non-existent in stable form on earth but plentiful in these stars.

Profit From Fish Waste

➤ FISHERMEN throw away 15% of their catch with present fishing methods. The U. S. Fish and Wildlife Service has started pioneering research to end this waste by finding profitable uses for the internal organs of fish. Research has begun at the Boston laboratory of the agency.

Before icing their catch at sea, fishermen now dress the fish and throw the viscera overboard, a seventh of the weight of the catch. Later, during processing on land, most fishery operators convert the head, backbone, and skin of the fish into a meal which is widely used in poultry feeds. In the research, attention will be given to possible medical uses of fish organs and the preparation of high-protein diet supplements. The research is a part of a project to determine the feasibility of freezing whole fish at sea for processing on land. The Fish and Wildlife Service has proved this method effective and economically practical.

Sea-freezing of whole fish preserves the quality of fish and makes possible longer fishing trips. If uses can be found for the parts now wasted, which are preserved by freezing, this technique will be even more profitable for commercial fishermen.

Cigarettes as Cancer Cause Still Burning Question

Tobacco and Lung Cancer

by JANE STAFFORD

➤ BURNING beside the glowing tips of some billion cigarettes today is the hotly debated question, Does cigarette smoking cause lung cancer?

Tobacco company stocks dropped sharply after recent medical reports charging that it does. Whether and how much cigarette sales are off will not be known exactly until records for the year are available.

Tobacco company experts are said to be more annoyed than scared, and to be readying answers to the medical charges.

When the worried smoker, however, asks his doctor what about it, the chances are he will be told to cut down on his smoking if he has been smoking heavily. Some doctors will advise stopping altogether, others may advise moderation, as most have in the past.

In the present state of knowledge, no one can guarantee that a person who quits smoking, or who has never smoked, will not get lung cancer. It can be said, however, that a person who has his chest X-rayed regularly has a good chance for early discovery of lung cancer if he develops one. And that an operation, especially in the early stages, to remove the cancer and the lung if necessary, has a good chance for success.

Primary argument linking cigarettes with lung cancer comes from statistics showing an increase in lung cancer has come during the same period that cigarette consumption has increased markedly. Backing this are statistics showing that in cases of cancer of the lung there is almost always a history of excessive smoking for a period of at least 20 years and that it is rare to find lung cancer in a nonsmoker.

But a Yale professor, who is director of statistical research for the American Cancer Society, E. Cuyler Hammond, says there is still no reliable statistical evidence to prove that cigarette smoking causes cancer. Referring to previous studies, he said that "certain investigators, including myself, are not completely convinced as to the validity of the results, in spite of the fact that a number of independent studies conducted in more or less the same way led to more or less the same apparent conclusions."

Right now Prof. Hammond is directing a study of the smoking habits of 204,000 men. This study for the American Cancer Society is reversing the usual direction of such studies. It is designed to learn the smoking habits of men while they are alive and compare these with the causes of their deaths when they die. In the past, the comparison has been of smoking habits of patients with lung cancer and those without it. This has the weakness that until a person develops lung cancer or until he dies, no one can say he is not a lung cancer patient or going to become one.

Some of the arguments linking cigarette smoking to lung cancer come from laboratory experiments with mice. Cigarette smoke tar painted on the skin of mice over about a period of a year will produce cancer in these animals. An answer to that could be found from laboratory experiments in which other tars painted on mouse skin produced cancers.

Cigarette smoke tar is not the only possible cancer-causing product of combustion to which men and women have been increasingly exposed in the past quarter century. Fumes and gases that pollute city air on a smoggy day can do more than smart the eyes. They can, in the opinion of more than one scientist, take a good share of the blame for the increase in lung cancer. Chemicals from these fumes, when painted on mouse skin, will also produce cancers.

More convincing, perhaps, than the skin-painting experiments are some reported about a year ago and also earlier. In the latest ones, mice were housed in a special cage with a specially designed automatic smoking machine. While the animals did not actually smoke cigarettes, they came as close to it as scientists could contrive. At least they breathed cigarette smoke from cigarettes smoked by the machine at the rate of one an hour for a 12-hour day.

Half a lifetime of this increased the chances of getting lung cancer by about one-third — that is, for mice with a hereditary tendency to lung cancer. Similar experiments run in 1943, but for a shorter time in mouse life, showed no difference in lung cancers between mice who "smoked" and those that did not. Maybe this means the smokers who quit have a better chance of escaping lung cancer than those who continue the habit.

Glandular activity which drives men and women to chain smoke may be a factor in causing lung cancer rather than the tobacco itself. This idea was advanced last year by a professor of surgery who has seen and operated on many lung cancer patients. He pointed out that there are numerous authenticated cases of lung cancer in persons who never used tobacco in any form.

Arsenic, sprayed on tobacco plants to destroy crop-eating insects, has also been blamed for the cigarette-lung cancer situation. If true, the remedy would be simple enough.

If cigarette smoking is related to lung cancer, it will be important to know the degree of the relationship, Prof. Hammond has pointed out. To use such a finding to save lives, either people must be persuaded to give up smoking or the harmful ingredients must be discovered and removed from cigarettes. Unless the relationship between lung cancer and smoking is large, neither is apt, in his opinion, to be accomplished.

What is believed to be the oldest collection of proverbs and maxims in man's recorded history dates back some 3,600 years, antedating the Biblical book of Proverbs by more than 1,000 years.

The vitamin pantothenic acid has been shown to be an essential part of some of the most important enzymes in the body.

Restore Brain Chemical Process in MS Patients

Chemical Effects in MS Disease

➤ A CHEMICAL which tends to restore normal brain and nervous tissue chemistry in multiple sclerosis patients has been discovered by Drs. John E. Adams and Gilbert S. Gordan of the University of California School of Medicine, San Francisco.

The National Multiple Sclerosis Society, which supported their work, calls the discovery significant in that it may lead to the cause and possible treatment of this central nervous system disease which afflicts an estimated quarter of a million persons in the United States alone.

The chemical whose effect was discovered by the California scientists is a succinate. They came to its discovery through a study of the way the brain tissue of MS patients handles another chemical, glutamic acid.

In 12 of 15 normal persons, amidation of glutamic acid was carried on by the brain tissue, they found. This, it is believed, represents a mechanism for removal of ammonia within the brain cells. Removal of the ammonia is a necessary factor to avoid poisoning in the nervous tissue.

In eight out of nine MS patients, however, the amidation of glutamic acid was not carried on. But injections of succinate into the veins of the patients restored the amidation pattern toward normal.

Multiple sclerosis patients should avoid situations that will sound the body's normally protective alarm mechanism, warns Dr. Robert T. Long of Boston.

The alarm mechanism is an automatic preparation for "fight or flight." But anger, fear and anxiety which start this alarm reaction may, in the multiple sclerosis patient, be accompanied by irregular and non-symmetrical muscular contractions. Serious loss of balance and perhaps dangerous falls may result.

Since common characteristics of MS include lack of balance and muscular coordination, and nerve spasms in the muscles, the aggravation of these by the alarm reaction can precipitate severe disability. Case histories show that attacks may be precipitated by emotional distress or disorder.

Multiple sclerosis is a disease of the central nervous system. Its chief symptoms are disorders of speech, eyesight, gait or bladder.

A clue to natural resistance to the disease, which may give a lead for treatment, comes from studies showing that attacks preceded or accompanied by a significant rise in blood pressure have a good outcome. Attacks not accompanied by such blood pressure change have an unfavorable outlook. This finding, by Dr. Leo Alexander of the Boston, Mass., MS Research Clinic, suggests that the rise in blood pressure may reflect excessive secretion of certain body chemicals or over-activation of the pituitary gland.

For The Home Lab

Organic Reactions: Oxidation

Part I

by Burton L. Hawk

Commencing with this article, we propose to inaugurate a series of experiments of organic reactions. The experiments are designed to illustrate basic processes used in organic chemistry. It is our earnest desire that you will find this series helpful, entertaining and useful.

➤ First, we will consider *oxidation,* a very important reaction used in the preparation of hundreds of compounds. Just what is oxidation? We usually think of it as a process which "adds oxygen" to a substance. But it involves much more than simply adding oxygen to a compound. Under the term "oxidation," we include the removal of hydrogen, or the replacement of a hydrogen atom by oxygen, or the breaking of a carbon-to-carbon linkage with the addition of oxygen, or even an increase in the valence of carbon.

The substance employed to perform one of the above operations is known as an *oxidizing agent,* and there are many of them used in organic reactions. Each one has certain advantages which make it suitable for a particular reaction. There are so-called "strong" oxidizing agents and "weak" oxidizing agents. In choosing an oxidizing agent for a particular reaction, the following must be kept in mind:

1. Is it strong enough to complete the desired reaction?

2. Will it form any undesirable side reactions?

3. Will it permit stopping the reaction at the desired point?

4. Will the compound formed as a result of reduction of the oxidizing agent interfere with the desired product?

You are familiar with the common oxidizing agents such as dichromate and sulfuric acid, potassium permanganate, and nitric acid. Others used in organic reactions are nitrobenzene, lead peroxide, hydrogen peroxide, selenium dioxide, lead tetra-acetate, and, of course, the powerful ozone. It is also possible to oxidize by electrolytic reaction.

Oxidation of Primary Alcohols

Primary alcohols can be oxidized to form aldehydes first and then acids. If a "weak" oxidizing agent is used the corresponding aldehyde is obtained, but if a "strong" oxidizing agent is used the reaction continues to form the corresponding acid.

To prepare the oxidizing agent dissolve one gram of sodium bichromate in 10 cc. of water. (Although the sodium salt is preferable, you can use potassium bichromate if the former is not available.) Cautiously add one cc. of concentrated sulfuric acid and stir.

Separate the solution into four equal portions in four test tubes.

Add 10 drops of ethyl alcohol to the first test tube. The alcohol is quickly oxidized to acetaldehyde, which you can recognize by its characteristic odor of green apples.

To the second portion of the oxidizing agent, add 10 drops of benzyl alcohol. This alcohol is oxidized to benzaldehyde which you will recognize from its odor of bitter almonds. If the reaction is slow, warm the solution *gently*.

To the third portion of the oxidizing agent, add 10 drops of iso-amyl alcohol. In this case iso-valeraldehyde is obtained, which has a pungent apple-like odor somewhat similar to that of acetaldehyde. Again, warm gently if necessary.

To the final portion of the oxidizing agent, add 10 drops of methyl alcohol. In this case you should obtain—formaldehyde? Well, only momentarily. You may notice a fleeting odor of formaldehyde, but methanol is so easily oxidized that the reaction tends to go all the way to formic acid and even further on to carbon dioxide and water. To obtain the aldehyde from methanol a different type of oxidation must be employed which we will consider later on.

In all the above oxidation reactions, you will note the yellow dichromate solution turns dark green. This is due to the reduction of the dichromate ion to the chromic ion. Using the ethyl alcohol as a typical reaction, we have: $3C_2H_5OH + Na_2Cr_2O_7 + 4H_2SO_4 \rightarrow 3CH_3CHO + Cr_2(SO_4)_3 + Na_2SO_4 + 7H_2O$.

Oxidation of Aldehydes

Aldehydes are very easily oxidized to the corresponding acids. We could have continued our oxidation of the alcohols all the way to obtain the acids. However we shall use aldehydes as our starting point here in another illustration of the oxidation reaction.

Just for variety, suppose we use potassium permanganate this time for our oxidizing agent. Prepare a dilute solution of the reagent (about ½ gram in 50 cc. of water) and pour a portion of it into three test tubes.

In the first tube, add 10 drops of acetaldehyde and stir. You should be able to recognize the vinegar-like odor of acetic acid. If not, warm the solution gently.

To the second portion, add 10 drops of formaldehyde. Formic acid is obtained this time. Filter the solution and drop a piece of blue litmus paper in the filtrate. It should turn pink indicating the presence of formic acid.

To the third portion, add 10 drops of benzaldehyde. Benzoic acid is the end product of this reaction.

Dehydrogenation

Another phase of oxidation is known as *dehydrogenation*. A good example of this type of reaction is the formation of formaldehyde from methyl alcohol with metallic copper.

Wind one end of a clean copper wire into a small spiral. Grasping the other end with a pliers, heat the spiral in a flame until it glows bright red. Then plunge the red-hot wire into a solution of methyl alcohol diluted with a little water. Repeat this operation several times and you will soon

be able to detect the presence of formaldehyde by its characteristic pungent odor.

No oxygen or oxidizing agent is employed in this reaction. Hydrogen is simply taken away. The copper is not an oxidizing agent, but a *catalyst*.

This method can only be used for the production of the more volatile aldehydes. Acetaldehyde can be obtained in this manner, although not quite as easily as formaldehyde. You may try it if you wish, proceeding exactly as for the methyl reaction.

➤ "By the way, *Pilbeam, how long have you been with the company?*"

Schools, Homes Stimulate Science Careers in Youth

Training For Science Careers

➤ WILL your child be a scientist when he grows up?

He may, if you and his teachers encourage him a bit.

School and home are the most powerful influences toward shaping future science careers.

A questionnaire sent to teen-aged finalists participating in the National Science Fair last spring revealed that nearly 41% of the boys and girls credit their school teachers with sparking their first interest in science. Science teachers were cited in particular.

About 20% of the finalists named "home influences" as kindling their desires toward things scientific.

Tracing the inceptions of their science-mindedness, other teen-agers listed science magazines, science-fiction movies and friends as sources of inspiration. One person said he became interested in science while he was ill.

"My doctor used to talk to me a lot about becoming a physician," he said.

Another boy became intrigued with astronomy when an elderly lady visiting his family pointed out some of the constellations in the heavens, and gave him a book containing pictures of a trip to the moon.

A third boy literally was jolted into science at the age of three when he stuck his fingers in an electric light socket. In his subsequent 15 years, the lad has been plugging away at the task of making home electrical mechanisms safer.

Although the greatest number of students said they were awakened to science when 14 years old, one of the 65 respondents remembered that his curiosity in science was first aroused when he was two years old. Three other traced their interest back to the tender age of three. Nine reported their scientific bent started at a preschool age.

Some of the young scientists were unable to pinpoint the time they became interested in science.

"We feel the responses to our questionnaire show that many more children can be directed toward science careers if parents and teachers actively work toward it," stated Joseph H. Kraus, coordinator of the National Science Fair.

"You never can tell just what the stimulus may be which starts a youngster on his scientific career. It may be a toy chemistry set he gets for Christmas, or it may be a dismantling of the family alarm clock.

"It might be another person's enthusiasm for the world of science. A science teacher's exuberance for the subject he teaches certainly is vitally important."

Many studies have shown that the ability and perseverance necessary to become a scientist is detectable early in a child's life, he said, but must be cultivated in most cases over the "growing years" if it is to be sustained into adulthood.

▶ ANALYZING *the soils of southwest Virginia gave John R. Kirk, Jr. of Martinsville, Va. the subject for his exhibit at the Second National Science Fair, held at St. Louis, Mo.*

Exhibits Show Many Interests

▶ THE BOYS AND girls who will bring their exhibits to the Fifth National Science Fair this spring at Purdue University will illustrate a wide variety of interests in many kinds of scientific work.

The object of the science fair program is to help provide America with technically trained men and women needed to carry today's scientifically based civilization.

Through participation in their local fairs, many of America's youth find places for themselves in scientific fields. Cases already have appeared where local fairs have spurred some boys and girls to go on to college rather than to stop their formal education with high school.

The program has created so much enthusiasm that various institutions and professional groups have pitched in to help newspapers and educators set up local fairs and get them going. These groups include colleges, universities, local professional societies, boards of education, chambers of commerce, research organizations, scientific, technical, industrial and medical associations.

Last year's National Science Fair, held at Oak Ridge, Tenn., attracted 71 high school science pupils from 30 areas. This was nearly double the figure for 1952. This year the number of finalists which each newspaper can send has been cut to two, due to the rate at which the National Fair is

➤ FROG DISSECTIONS *to show the circulatory, digestive, muscular, and reproductive systems and the external anatomy, and a soap carving of the brain were made by Gloria Mae Hottman of Grand Forks, North Dakota, for her exhibit at the Second National Science Fair, St. Louis, Mo.*

growing. But the number of areas represented is expected to double again before the 1954 Fair opens in May.

The entrants come from all over the United States, from both rural and city high schools, and their interests cover all the fields of science. Their scientific curiosity has in most instances been whetted by participation in their school science clubs. In the science club program students learn by conducting their own science projects, and find that such work is also fun.

The 15,000 science clubs in the public, parochial and private high schools of the country, which are affiliated with Science Clubs of America, are stimulating young people today to take their places among those who will carry on the scientific traditions of our country.

Science Clubs of America, which sponsors the National Science Fair, is administered by Science Service.

Student's Apparatus and Procedure for Working

Chromatography

by WILLIAM BEAVER, *9th S.T.S.*

➤ MY INTEREST in chromatographic adsorption analysis began when I heard a chemistry professor mention the field as a new and promising possibility for research. This interest was further aroused when I had read some books and articles dealing with the subject, which seemed to have almost limitless and untouched fields waiting to be developed. I realized that the equipment necessary for experimentation in the field could fairly easily be obtained or improvised.

The history of my experiments is one of trial and error, and in the early stages mostly error. However, after numerous failures, I developed a technique adequate to repeat certain experiments which had previously been done in the field and to do several others on my own. During the course of my work I had to read books and papers on all sorts of allied subjects in order to get a better idea of the relationships of the various pigments with which I was working, and of the nature of solvents and adsorbents.

Some of my experiments were not as satisfactory as I had hoped because I had neither the equipment nor the knowledge to determine the composition of many of the pigments and allied substances that I had isolated, and I was not able in many cases, even with some of the more common pigments, to prepare a large enough amount of these pigments to determine with certainty their true identity.

I hope, in the future, to be able to gain access to a photospectrometer with which I can do further and more accurate work in chromatography, particularly that of those compounds which play a part in animal physiology.

The Laboratory

Due to the volatile and flammable nature of the solvents with which I was to work, I located my laboratory in a small room which was walled off from the rest of the cellar by a partition, and which had exceptionally good ventilation. The experiments were done at the far end of the room from the door, no obstructions being between the door and the work table. Two carbon tetrachloride fire extinguishers were placed near the door. The solvents were kept in a tight box, and no flames were allowed in the room.

The Apparatus

Adsorption columns vary considerably in size, depending upon the particular job for which they are to be used. Taylor and Urey used a column a hundred feet long and 1.25 in. in diameter, holding 13 kg. of Na zeolite, for the separation of the isotopes of lithium. [1, 2] At the other extreme lie those of Becker and Schöpf, which had an internal diameter of 1 mm.[3] The columns I used were made of ordinary lime glass tubing with internal diameters of 4, 6, and 8 mm which had been cut into twelve

▶ EQUIPMENT *for chromatographic adsorption analysis formed the exhibit shown by William Beaver at the Ninth Science Talent Institute. William came from the Albany Academy, Albany, N.Y.*

inch lengths and reamed out at one end to facilitate filling.[4] The use of glass wool instead of cotton wool to support the column removed the necessity of crimping the tube, as glass wool, when packed into the tube with considerable force, will remain firm even under a strong vacuum. The construction and set-up of the remainder of the apparatus is evident from diagram 1.

The Chemicals

The three factors which most affect the success of the method are the choice of adsorbent, solvent and elutent. In my experiments I made use of the following adsorbents and solvents, the more polar solvents being used as elutents. Some were used in almost all cases, while others were utilized only in one or two special instances. (*See page 28.*)

Because of the fact that there was no established method but rather an empirical one of selecting adsorbent, solvent, and elutent, this selection was prone to be quite costly in both time and chemicals. This was perhaps my biggest problem until I found an article describing a most efficient and simple way of solving it.[5]. About a tablespoon full of the adsorbent to be tested is put in a petri dish and

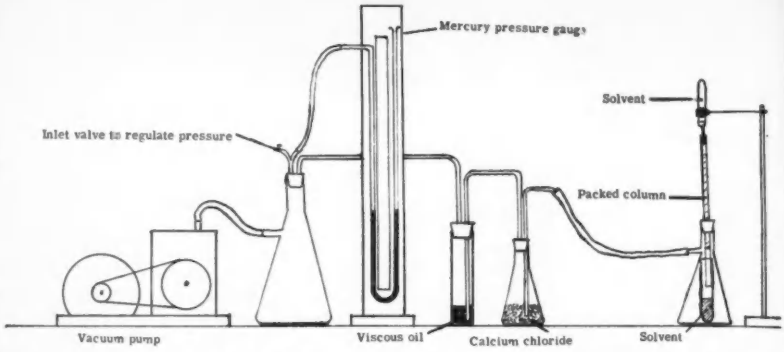


Diagram 1. Vacuum train to draw solvent through chromatography column.

shaken to form a wedge shaped layer on the bottom. A few drops of petroleum ether extract of the sample is allowed to fall on the edge of the adsorbent from a micro-pipette, followed by solvents in order of increasing polarity. By this mehod, several tests on different adsorbents and solvents may be carried on simultaneously and without much expense or waste of time. (Diagram 2).

Adsorbents (listed in order of decreasing activity)
Activated alumina (Merck, stand. acc. Brockmann)
Lime (freshly slaked)
Calcium carbonate
Sodium carbonate
Sucrose
Solvents and elutents (listed in order of increasing polarity)
Petroleum ether, b.p. 30-65°
Carbon tetrachloride
Carbon disulfide
Ether
Acetone
Benzene 25%, pt. ether 75%
Benzene
Benzene 99%, methanol 1%
Methanol
Water

Procedure and Results

Because of lack of space, I will record three of my experiments in detail and several others in outline form. Most of the experiments whose results were of no use or unsatisfactory are omitted, while a few are retained to illustrate basic faults in technique.

Experiment I

This experiment was done in order to test the use of the chromatographic method for concentration of materials from dilute solution.

1 gm. of dried powdered petals of Zinnia elegans was steeped in 35 ml. of methanol for one day. 20 ml. of methanol was added and the extract was filtered. 50 ml. of very pale yellow methanol resulted. The extracted zinnia petals were dried and carefully weighed, the difference in weight being so small as not to be measurable. 5 ml. of the methanol extract was added to 50 ml. of petro-

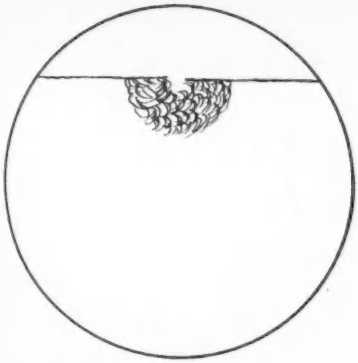


Diagram 2-I. About ½ cc of extract is allowed to fall on the upper edge of the absorbent from a micro-pipette.

Diagram 2-II. Several cc of fresh solvent is run onto the upper edge of the slide of adsorbent. If sufficient development does not take place, different solvents and elutents are used in order of increasing polarity.

leum ether and 20 ml. of water, and the whole mixture was violently agitated and poured into a separatory funnel. As soon as the separation was fairly well evident, the mixture was washed with an additional 20 ml. of water and the then colorless water-methanol mixture was drained off.

Diagram 2-III. Finished chromatogram.

The resulting petroleum ether extract was filtered, dried, and further diluted with 100 ml. of petroleum ether, yielding a solution with no color visible.

Two 8 mm. columns were prepared from alumina and the extract was divided into two parts, one of which was passed through each column. The columns were nearly identical, all the coloring material being adsorbed in the first 5mm of the alumina. The liquid recovered in the percolate was evaporated in vacuo and proved to be pure petroleum ether. Each column was used to test a different method of elution.

In the first column, the top centimeter of the adsorbent, containing the pigment, was scooped out, eluted with 3 ml. of methanol, and filtered. The filtrate was mixed with 2 ml. of petroleum ether and 4 ml. of water in

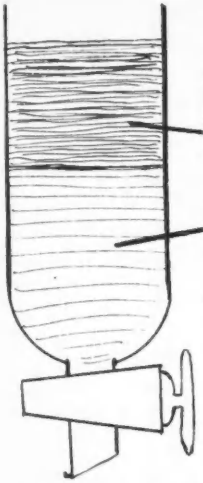


Diagram 3. Separation of the carotenes by immiscible solvents.

a small separatory column and the petroleum ether evaporated in vacuo, yielding a small stain.

The second column was sucked dry and washed with methanol, the colored washings being treated in the same way as in the first column. This method, the flowing chromatogram, is very useful when the adsorbent cannot be extruded or otherwise removed from the column for elution.

If we consider that 10 mg. of pigment were removed from the petals (weighing showed that the amount removed was considerably less than this) the final concentration of the petroleum ether extract before it was put through the column was 9:1,500,000; and yet this infinitesimal amount of pigment was concentrated without difficulty in the column. It is obvious that the chromatographic method could be of great value to any investigator desiring to remove from very dilute solutions some substance or group of substances. This method has already proved invaluable in the extraction and preparation in a pure state of the minute amounts of hormones which appear in the body fluids.

Experiment II

Three isomers of carotene (alpha, beta, and gamma) were isolated from carrot root in the following manner.

5 gm. of dried carrot root (Daucus carota) were ground to dust in a mortar and 50 ml. of a methanol-petroleum ether (1:1) mixture were added. This mixture was ground, 5 ml. of water added, and poured into a separatory funnel. The upper, petroleum ether, layer contained carotenes and xanthophyll esters; while the lower, methanol-water, layer contained xanthophylls and carotinoid acids.[6] (diagram 3). The lower portion was discarded. The upper portion was concentrated in vacuo to 20 ml. and treated with 3 ml. of a 5% NaOH in methanol solution to saponify the xanthophyll esters. The resulting mixture was washed several times with

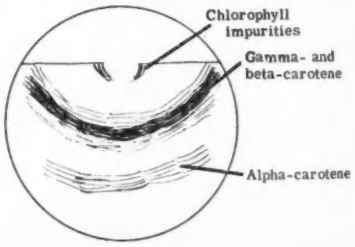


Diagram 4. Carotenes separated on a slide, using alumina.

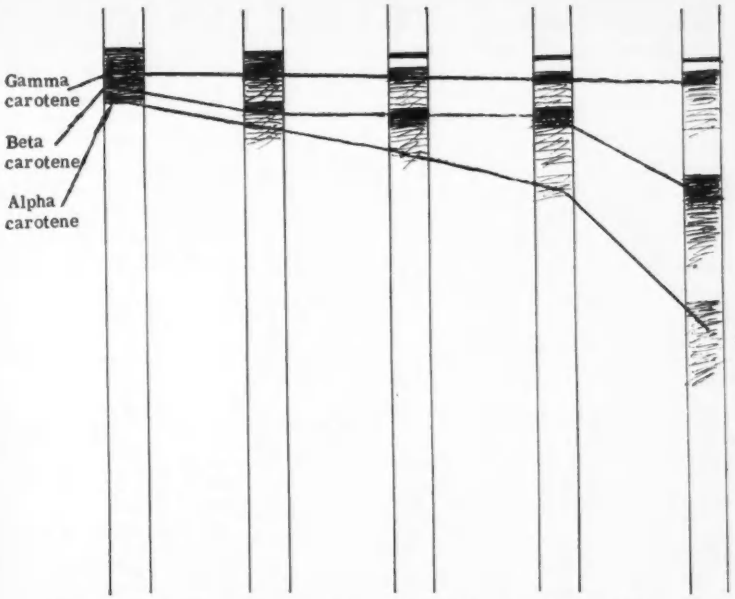


Diagram 5. Carotenes separated in a tube of alumina by the flowing chromatogram technique, showing development of the column.

85% methanol and water, and was then washed several times with pure water to remove the last traces of methanol. The petroleum ether was filtered, yielding a yellow-orange solution of carotene.

A micro method slide was prepared with alumina. The slide was washed with petroleum ether followed by benzene-petroleum ether (1:3) (diagram 4).

An 8 mm. column was prepared from alumina and mounted in the usual fasion. 10 ml. of the extract were passed through and the chromatogram was washed with benzene-petroleum ether (1:3) until three well defined rings were formed, gamma carotene, beta carotene, and alpha carotene (diagram 5). A flowing chromatogram was made with methanol-benzene (1:99) and samples of the three isomers were obtained in an almost perfectly pure state.

Experiment III

10 gm. of dried corn leaves (Zea mays) were steeped in 100 ml. of methanol for 24 hours, filtered, and the residue washed with an additional 50 ml. of methanol. 75 ml. of this extract plus 50 ml. of petroleum ether and 50 ml. of water were violently agitated and placed in a separa-

tory funnel where all the color was concentrated in the petroleum ether layer in about two hours. This layer was drawn off after the water-methanol was discarded and passed through a filter, producing a very concentrated extract.

A micro method slide was made from alumina. The best development was secured by using benzene as a solvent.

An 8 mm. column was packed with alumina and 20 ml. of the extract poured in. The column was developed with benzene. The column was washed with benzene until all the carotene and xanthophylls had passed through into the percolate and then it was sucked dry. The upper 4 centimeters of the adsorbent that contained the chlorophyll were scooped out and eluted with 5 ml. of methanol to remove the chlorophyll which was then transferred to 5 ml. of petroleum ether. The petroleum ether was passed through a fresh column like the first and the isomers of chlorophyl were completely separated into two bands upon washing with benzene. In this manner the two isomers were prepared in a pure state and in sufficient quantity for subsequent elution and concentration in vacuo.

The xanthophylls were removed from the percolate by adsorbtion upon "Alcoa" activated alumina. The petroleum ether-benzene carotene solution was evaported in vacuo and the carotene was dissolved in 1 ml. of petroleum ether. A micro method slide was made of alumina acc. Broc. and was washed with petroleum ether. Upon this slide the carotene was broken into two isomers, carotene alpha and carotene beta.

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Sea Urchins Burrow Through Steel

➤ SOLID STEEL is hardly a challenge to the purple sea urchin, one of the sharp-spined "porcupines of the sea," when it decides to dig a burrow.

Twenty out of 40 steel pilings of a pier near Ellwood, Calif., were put out of commission when purple sea urchins (*Strongylocentrotus purpuratus*) bored holes through steel plates three-eighths inch thick.

Sea urchins attach themselves to rock, coral, and cement, wood and metal pilings, where they pass a sedentary life. They exert a corrosive action on their supports, to make depressions where they can stay well protected.

Most people are delighted that the prickly sea urchins are inclined to keep out of the way. (The spines of some species are extremely poisonous.) But when they bore into expensive pier pilings, their retiring nature causes them to rank with barnacles, teredo worms and other such "public enemies" of marine construction.

Discover Groups and Types Of Mysterious Blood Platelets

Advances in Blood Chemistry

➤ FINDING of groups and types for the mysterious platelets of the blood was announced by Drs. Mario Stefanini, Jyota B. Chatterjea, Gerald I. Plitman and William Damashek and Mrs. Irma B. Mednicoff of the New England Medical Center and Tufts Medical School, Boston, at the Chicago meeting of the American Association of Blood Banks.

Platelets are colorless, disk-shaped bodies found in the blood of humans and all other mammals. They play a part in the blood clotting mechanism, but are still not well understood. Transfusions of platelets from blood may help save victims of any future atomic bomb attacks, it is thought, since such platelet transfusions have saved dogs and other animals from killing doses of X-rays.

The Boston scientists find that platelets can be grouped and typed as red blood cells are before blood transfusions.

The four groups and six types of platelets are sometimes incompatible, which suggests that if platelet transfusions are much used in future, their types will have to be identified before use.

A blood disease of new babies, thrombocytopenia, in which blood oozes out of the vessels under the skin, may be due to platelet incompatibility between mother and unborn baby, just as Rh incompatibility causes trouble of another kind for the baby.

Adults also suffer from the blood-oozing disease and the gradual failure of repeated platelet transfusions to help them may be due to incompatibility of the donor's platelets with the patient's.

There is no correlation between the four platelet groups in human blood and the familiar four groups of red blood cells.

Some Blood More Poisonous

➤ DISCOVERY that the blood serum of certain mental patients is more poisonous to developing tadpoles than blood from normal persons is announced by Dr. Roland Fischer of the Department of Public Health and General Hospital, Regina, Saskatchewan, Canada, in the journal, *Science*.

Blood serum from normal men is more poisonous to the tadpoles than that from normal women, he also finds.

The discovery seems to show that there is a stress chemical formed in the human body which can be detected in the blood serum and also in the kidney excretions. Dr. Fischer does not give this chemical a name, but reports various findings showing its relation to stress and to the serious mental sickness, schizophrenia.

Scientists have long been looking for such a chemical difference between normal persons and schizophrenics.

Blood serum and urine from schizophrenia patients causes significantly

higher mortality among developing toad tadpoles than that from normal persons when the substances are added in the same dilution to the water in which the tadpoles are developing.

But when schizophrenic patients have been successfully treated or are having a period of spontaneous freedom from disease, the tadpole poisoning quality of their blood and urine is near that of normal, healthy persons.

Sign that this is a stress chemical comes from the finding that the difference between normals and schizophrenics also grows less on days when there is a sudden change in warm or cold weather front. Such weather changes make up a stress situation for some normal people, while schizophrenic patients react differently to weather and other stress situations.

Expectant mothers in the late months of pregnancy and patients with cirrhosis or cancer of the liver are between the normal persons and the acutely sick mental patients in the tadpole poisoning quality of their blood serum, Dr. Fischer finds. He thinks this also is a sign that the tadpole poisoning quality is related to the degree of stress the person is under.

Dissolves Blood Clots

➤ A NEWLY-ISOLATED fraction of human blood can be used to dissolve dangerous blood clots within the veins, Drs. Eugene E. Cliffton and Carlos E. Grossi and Miss Dolly Cannamela of Memorial Center for Cancer and Allied Diseases, New York, reported at a recent meeting of the American College of Surgeons.

The blood fraction is called plasminogen. In trials on dogs, cats, white rabbits and mokeys it rapidly dissolved clots in the veins when the enzymes, streptokinase, streptodornase and trypsin, had failed.

Fear that the dissolution of the clots would free particles that would travel into the blood stream and block the lung veins was not borne out, they said.

The material, thus far, has been tried on human patients only as a local application for cleaning up the debris of wounds and ulcers.

Tracer Tells When Bone Grafts Heal

➤ RADIOACTIVE phosphorus can help the doctor tell when a bone graft is "taking." Studies showing this were reported by Drs. Clifford L. Kiehn and Donald M. Glover of Cleveland at a recent meeting of the American Association of Plastic Surgeons.

The new method uses radioactive phosphorus as a tracer. It is injected into the patient immediately after the new piece of bone has been grafted into place. If the graft is successful, the phosphorus will be carried into the graft by the exchange of tissue fluid. Its presence can be readily detected in the graft because of its radioactivity. The amount of phosphorus in the bone increases in proportion to its development of new blood vessels.

The method is expected to be helpful particularly in cases when the graft is taken from a bone bank instead of the patient's own bones.

New Atom Smasher Cheats on Physics Law

News In Atomic Affairs

➤ A "SWINDLETRON," a new kind of atom-smasher which cheats on an elementary law of physics, is being developed at the University of California.

The law of physics says that in an atom-smasher only one boost of energy can be given to atomic projectiles by a single electrical impulse. The "swindletron" gives two boosts of energy per electrical impulse.

The "swindletron" can operate in the region of several million electron volts, but cannot rival in energy the big cyclotrons, cosmotrons and bevatrons. However, scientists say it will operate cheaper, easier and more safely in the energy ranges now covered by Cockcroft-Walton and Van de Graaff atom-smashers.

In the Berkeley pilot model "swindletron," more formally called the charge exchange accelerator, protons, the nuclei of hydrogen atoms, are used as atomic bullets.

The protons are shot at about 30,000 volts through a thin, uncharged sheet of aluminum. In this "capture" foil, the slow-moving protons tend to pick up two electrons each.

Being negatively charged, the projectiles are then pulled violently toward another aluminum screen which is positively charged. The particles are boosted to 500,000 volts by this charge.

As they rush through this screen, the fast particles tend to lose their two electrons. So on leaving this "stripping" foil, the particles are once again naked protons with a positive charge. They are violently pushed away from the foil, receiving another 500,000 volt boost.

Thus, with a single 500,000 volt charge, the protons are accelerated to 1,000,000 volts. The physicists get twice as much energy out of the machine as they put in. In larger versions of the machine, it will be possible to get 4,000,000 volt protons with an expenditure of 2,000,000 volts of energy. Four million electron volts is the energy range of a standard type Van de Graaff.

The idea of the "swindletron" was conceived independently by Dr. Luis W. Alvarez, professor of physics at Berkeley. After his publication of the idea, he learned that it had been patented in 1936 by Dr. Willard Bennett, of the Naval Research Laboratory, Washington, D. C., although Dr. Bennett had never published a scientific paper on the subject. The small pilot model in Berkeley, the first of the "swindletron" species, is being developed by Dr. John R. Woodyard, professor of electrical engineering.

Full-Scale Atomic Reactor

➤ IN 1956 or 1957 some 60,000 kilowatts of electrical energy produced by a full-scale atomic reactor will be the first major peaceful production of atomic energy.

When Commissioner Thomas E. Murray of the Atomic Energy Commission made known in a Chicago

speech that this atomic power plant is under construction, it became the fourth major effort of the AEC in the power field. It will be installed at some atomic energy plant.

Three atomic power plants for submarines are well along, one by Westinghouse which is to propel the Nautilus, and two by General Electric, one of which is a land-based prototype and the other to be placed in the Seawolf.

Two other reactors are producing power, somewhat incidentally: the breeder reactor in Idaho and the homogeneous reactor at Oak Ridge.

The new reactor and prime bid for peaceful use will be a Westinghouse production. It is the power plant that was originally planned for a Navy aircraft carrier. Congress authorized the AEC to proceed with a peaceful application of this reactor plan when the Navy decided not to go ahead with it.

A pressurized water reactor, the new 60,000 KW job is somewhat like the other Westinghouse atomic "engine" which uses water for moderator and coolant. The two General Electric power plants use liquid sodium metal as the heat transfer medium.

Private industry is not yet ready to enter into full-scale atomic power reactor construction as a risk venture, even if the atomic energy law were modified. For this reason, the government is taking this major step in atomic power to keep ahead of any Russian efforts in atomic power production.

300 Man-Years of Work

➤ More than 300 man-years of work were required to complete the cosmotron, giant atom smasher at the Brookhaven National Laboratory, officials have revealed.

The total cost for development, design, construction and testing was about $7,000,000, Dr. M. Hildred Blewett, editor of the first comprehensive report on the project, states. The magnet and its power supply, and the building and auxiliary equipment cost about one-half of the total, he estimates.

Construction of the cosmotron was officially begun in July, 1948. Protons, the hearts of hydrogen atoms, were "first injected into the completed cosmotron in March, 1952," Dr. Leland J. Haworth, director of the laboratory, reports. Circuits are now being constructed to raise the energies of the protons to about three million electron volts, he reports in *Review of Scientific Instruments*.

Mineral Named for Chemicals

➤ Umohoite is the synthesized name of a newly-found natural uranium mineral announced by Prof. Paul F. Kerr of Columbia University. Found so far in only one Marysvale, Utah, mine, it contains 48% uranium, compared with 50% to 65% in the usual pitchblende ore. Its name comes from the elements in it, the chemical symbols for uranium, U, molybdenum, Mo, and hydrogen, H, and oxygen, O, in water, plus the suffix used for minerals, "ite."

Toothbrush Better Than Medicated Dentifrices

The Brushing Does It

➤ THE TOOTHBRUSH, properly used, does more to keep the teeth and gums healthly than any medicine or chemical put into tooth pastes and powders, from enzymes to penicillin.

This sums up the opinions of six dental scientists at the recent meeting of the American Dental Association in Cleveland. Among the scientists were some who have been working on dentifrices with special chemicals in them intended to check decay.

All agreed that a dentifrice that has been proved to prevent tooth decay or gum disorders has not yet been developed, although some are being tested with the hope that they may prove effective.

Here, briefly, is what the experts said:

Dr. Leonard S. Fosdick, Northwestern University Dental School, Chicago, who has been studying enzyme "inhibitors:"

During the past 10 years, the American public has been led to believe that by brushing the teeth with various types of preparation, dental caries could be prevented. Unfortunately, the expectations as aroused by clever advertising have not been fulfilled. Before any final conclusions (on the anti-enzyme approach) are reached, clinical tests must be performed wherein the actual incidence of carious lesions (decay) is determined. Actually, clinical experiments of this type are now under way, but as yet no information is available to indicate the effectiveness of these compounds against clinical caries.

Dr. John W. Hein, School of Medicine and Dentistry, University of Rochester, N. Y., on chlorophyll dentifrices:

Never has a substance been so exploited and prostituted by ridiculous applications. It is evident that the use of chlorophyll derivatives as caries preventive agents is still very much in the laboratory stage, Any inference that these agents are effective against human tooth decay is pure speculation. Since salivary flow rapidly decreases the concentration of agents in the oral cavity, claims which suggest that chlorophyll derivatives give a protective deodorizing effect in the oral cavity of several hours duration should be viewed with suspicion.

Dr. Robert G. Kesel, University of Illinois School of Dentistry, Chicago, who has worked on ammoniated dentifrices:

The work being conducted and other work which is contemplated are designed to bring out more fully the role of these agents in relation to other potentially caries-inhibiting substances and dentifrices.

Dr. Helmut A. Zander, University of Minnesota School of Dentistry, Minneapolis, on antibiotics such as penicillin and aureomycin:

Unfortunately, I cannot state in the affirmative that any dentifrice ever will be a therapeutic agent. At present penicillin dentifrices are sold only on a prescription basis and are recommended primarily for cases of rampant caries or for use under a strictly supervised regime.

Dr. Albert H. Kniesner, Western Reserve University School of Dentistry, Cleveland:

Both positive and negative reports concerning the effects of medicated dentifrices on dental caries appear in the literature. Until corroborated clinical evidence from several reliable sources is forthcoming, "prescription pad" control of dental caries cannot be accepted as an established office procedure. The judicious use of the toothbrush rather than the type of dentifrice will contribute to the maintenance of healthy gingiva (gums).

Summing it all up, the moderator of the discussion, Dr. Thomas J. Hill, Western Reserve University School of Dentistry, Cleveland:

It is not definitely established that the dentifrices as used by the public materially decrease the dental caries (tooth decay) rate because of any specific therapeutic substance incorporated in them. It would appear that the present advertising claims of dentifrices are inclined to lead the public to put too much faith in some incorporated ingredient rather than on the prophylactic (cleansing) value of the dentifrice.

Water Torn Apart by Sound

➤ SOUND is being used to "tear apart" water and other liquids at the University of California at Los Angeles.

In a study of the tensile strength of liquids, William Galloway of the physics department induces sound in a fluid-filled glass sphere with a vibrator tuned to the resonance of the sphere. The sounds literally split the liquid apart, causing a cavity or giant bubble in the fluid.

Great pressures are generated around the cavity and when the sound is shut off the "walls" of water around the cavity collapse with tremendous force. Small microphones used in the experiment within the sphere are shattered by the force. A similar phenomenon occurs from vibration created by propellers of big ocean liners. The cavities collapse with such force that they make holes in propellers. After prolonged use propellers assume a spongy appearance from this effect.

The process by which the liquids are torn asunder isn't understood. Apparently it is related to the tensile properties of the fluids. It may be that a tiny, invisible air bubble is the basis of the process. When the water is expanded by the sound wave agitation, the air bubble may act like a pinpoint hole in rubber when the rubber is stretched.

In addition to water, benzine and salt solutions have been used in the study.

Incense cedar, grown only in California and southern Oregon, is now of little value except for pencil stock.

Created in a Test Tube, It Can't Displace Nature

Synthetic Sugar

Reprinted from The Sugar Molecule, *Sugar Research Foundation.*

▶ SOLUTION of one of the classical problems of carbohydrate chemistry—the synthesis of common sugar—was announced by one of Sugar Research Foundation's Canadian project directors, Dr. Raymond U. Lemieux, at the 124th meeting of the American Chemical Society in Chicago. Associated with him was Dr. George Huber, a Swiss. Both are at work for the National Research Council of Canada at the Prairie Regional Laboratory in Saskatoon, Saskatchewan, where Dr. Lemieux is head of the Crop Utilization Section.

The result obtained by Dr. Lemieux and Dr. Huber was not the first or the only synthesis of sugar, which is technically *sucrose,* but it had never been done before by *chemical* methods. In 1945 an *enzymatic* synthesis was achieved at the University of California, Berkeley, by a team consisting of Dr. W. Z. Hassid, Dr. Michael Doudoroff, and Dr. H. A. Barker, who jointly shared a Sugar Research Foundation prize of $5,000 for their work. Neither the chemical nor the enzymatic synthesis of sucrose, however, holds even a remote possibility of commercial application: sugar made by nature in the cane and the beet is the most abundant compound produced in pure form, and one of the cheapest foods.

The real significance of the work of Dr. Lemieux and Dr. Huber is that it advances the understanding of certain basic properties of the central compound in nature—the substance commonly known as glucose—which forms a portion of the sugar molecule. This knowledge promises to make easier the synthesis of many complicated substances. It is highly probable, Dr. Lemieux believes, that the work will prove valuable in providing biochemists with a means for preparing sugar molecules labelled at specific positions with radioactive carbon atoms. This would permit scientists to trace the path of the sugar molecule in life processes.

The synthesis of sugar was an indirect result of fundamental research on the chemical properties of sugars being conducted by Dr. Lemieux and Dr. Huber. In the course of their work they pieced together research data from widely scattered sources, and the results suggested to them that, if their interpretations of the evidence were correct, it should be possible to synthesize common sugar. Although well aware of the long history of failure which had been written by previous investigators, they decided there was enough hope of success to warrant risking the time and effort required.

Before braving the "Mt. Everest" of carbohydrate chemistry Dr. Lemieux tested his working hypothesis on another unclimbed peak in the

field of carbohydrate chemistry—the synthesis of malt sugar, or maltose. As in the case of sucrose, many previous attempts to synthesize maltose had proved futile. The synthesis of maltose and sucrose have a common stumbling block in that in each case it is necessary to attach a glucose molecule to another substance in a certain configuration, or position in space. The problem presented by maltose was readily solved—in fact, the first assault conducted by Dr. Lemieux was successful.

The effort to synthesize sucrose was begun last April. A derivative of glucose which was first prepared more than twenty years ago was treated with a derivative of fructose, or fruit sugar. Provided that the new idea was correct, the two substances should have interacted to form a derivative of sugar which could be readily converted to sugar itself. The initial attempts were in vain, but the two chemists persisted and by early June, through refinements in technique, obtained a mixture which appeared to contain sucrose. The isolation of the sucrose from the complex mixture proved to be a major problem. Nevertheless, thanks to the powerful modern techniques available, this was accomplished and, by the latter part of June, sucrose was isolated in pure form.

The yield was about 5.5 per cent. Altogether, several hundred milligrams—a fraction of an ounce—of sucrose has been synthesized so far. The synthesis confirms the current theory of the configuration, or position in space, of one major part of the sugar molecule.

In the course of the experiments, a third sugar was also synthesized for the first time. This substance, known as trehalose, occurs in some plants. This work was performed in collaboration with Dr. Herbert F. Bauer, a post-doctorate fellow from Austria.

Dr. Henry B. Hass, president of the Sugar Research Foundation, made the following comment on the Lemieux-Huber work:

"Like the conquest of Mt. Everest, the accomplishment of the synthesis of sucrose is exciting, interesting, and thrilling because so many eminent men tried and failed. Emil Fischer, great German chemist who first established carbohydrate chemistry on a firm foundation, tried to make sucrose by at least 20 different methods and failed.

"This is an important contribution to scientific concepts of chemical mechanisms. Sugar is central to our whole economy, not only the economy of our civilized society, but to the plant and animal world, since all the energy of the sun which is used by nature starts out as sugar, formed in plants by the chemical process of photosynthesis."

But as to any immediate commercial exploitation of the synthesis of sugar, Dr. Hass said: "It is as unlikely as the possibility that some real estate agency will have Mt. Everest cut up into lots and sold for development."

A submerged mold-fermentation process produces citric acid from such materials as commercial glucose, blackstrap molasses, cornstarch, and finely ground corn.

Specialized Packaging For Plant Nutritives

Tracery

Reprinted from Industrial Bulletin *of Arthur D. Little, Inc.*

A NEW way of feeding traces of minor foods to plants promises greener thumbs for home and commercial gardeners. Most plants need the "big three" of mixed fertilizer—nitrogen, potassium, and phosphorus—but some crops in some soils also respond spectacularly, through better growth or disease immunity, to the addition of other elements, including boron, copper, manganese, zinc, iron, and cobalt.

Quite recently, "fritted" trace elements have come on the market. The bulk product contains several of the trace elements as constituents of a powder comprising small glassy particles, or "frits." The term, borrowed from the porcelain enameling art, denotes a fine powder which results from grinding the flakes made by quenching a stream of molten glass in water. Trace elements are added to the original melt and are thus bound in glass in a relatively insoluble and non-toxic form. They are released to the soil gradually by slow dissolution of the frit particles.

A further development, now in the pilot stage, is incorporation of these fritted trace elements in an extruded vermiculite bar, cube, or disc which also contains the basic plant food ingredients, thus providing a complete soil culture medium. Seeds planted in or on this medium need only be watered; they can draw from their surroundings all the nourishment essential to their first stage of growth. This approach is expected to appeal to the grower of specialty crops who can realize a premium price if his crop is the first on the market. Eventually, seeds may be incorporated in the medium, so the home gardner could turn to his catalog for "a yard of beans," or "six feet of asters."

Climate, Not Iron, Protects Pillar

IT IS THE climate and not the kind of iron that has kept the famous iron pillar of Delhi, India, virtually unrusted since it was erected about 1,500 years ago in the fifth century, A.D.

J. C. Hudson of the British Iron and Steel Research Association reports in the British science journal, *Nature*, that both steel and zinc specimens exposed near the 23-foot, six-ton pillar showed very little corrosion in a year. The mildness of the climate instead of any intrinsic superiority of the iron itself has protected the pillar against any serious rusting.

Little or no rusting occurs unless the humidity exceeds 70% and this critical value is reached in Delhi only a short time during the whole year. Sulfur pollution that controls corrosion rate when humidity is high is very low near the pillar.

Three Unusual Metals and The Analogues of Sulfur

Analyzing For All the Elements

Group VI, a and b

➤ CHROMIUM, molybdenum and tungsten are true metals, but in their compounds they join with oxygen to form acid radicals which combine with more positive metals to form salts.

These elements can, therefore, be thrown down as precipitates during the course of qualitative analysis, as a result of their properties as cations. They can also be determined as acids if made to form characteristic compounds.

Chromium

This metal comes down as a pale greenish blue hydroxide in the classical procedures of qualitative analysis. The color of this precipitate shows that chromium is present, but removal of the element from solution is better accomplished in the form of lead chromate.

Chromic acid is a powerful oxidizing agent and this property, together with the strong color difference between compounds of chromium in different states of oxidation, is the basis of numerous methods of estimation by titration.

Quick methods of analysis have been worked out for many of the unusual metals present in special steels. Many of these metals form highly colored compounds and are capable of existing in several different states of oxidation. Possibility of interference when two or more such elements are suspected should be kept in mind when relying on color reactions for determination of the heavy metals.

Molybdenum

Hydrogen sulfide throws down molybdenum from acid solution as the brownish-black sulfide (MoS_3). This compound may be heated until it changes to the oxide, for quantitative determination of the metal. Or the element may be precipitated and weighed as lead molybdate.

Just as phosphorus may be determined as ammonium phosphomolybdate, addition of ammonia and orthophosphoric acid to a molybdenum-containing solution will precipitate the same yellow salt.

Tungsten

Neither hydrogen sulfide in acid solution nor ammonium sulfide in alkaline solution precipitate tungsten as the sulfide, but that compound is thrown down if the solution which contains ammonium sulfide is acidified. It is light brown in color and, as precipitated, is mixed with sulfur.

Tungsten forms three stable oxides and a large number of unstable ones. Tungsten dioxide, WO_2, has the lowest valence of the three. It is brown in color. Tungsten hemipentoxide, or ditungsten pentoxide, W_2O_5, the intermediate one, is blue. Tungsten trioxide, also called tungstic acid and

Group VI. Elements in Test Reactions

	HCl	H_2S	$(NH_4)_2S$	$(NH_4)_2CO_3$	Special Test
VI. a					
Cr	—	—	$Cr(OH)_3$	—	Lead chromate
Mo	—	MoS_3	—	—	Ammonium phosphomolybdate
W	—	—	(Prec. of WS_3 upon acidifying	—	"Tungsten blues"
VI. b					
O	—	—	—	—	Often calculated
S	—	—	—	—	Oxidized to sulfate, prec. with barium
Se	—	—	—	—	Isolated as element, colors flame blue
Te	—	—	—	—	Det. by spectrum
Po	—	—	—	—	Det. by radioactivity

tungstic anhydride, WO_3, is canary-yellow. This is the usual oxide, and the form in which the element is weighed in analysis. The other two oxides are obtained from it by reduction reactions. When tungstic acid is treated with hydrochloric acid plus some ammonium, zinc or tin a blue color appears which is a test for tungsten.

Oxygen and Sulfur

In spite of the great dissimilarity in physical form of these two elements in their uncombined forms, oxygen and sulfur form parallel series of compounds. In such a series the sulfur atom may be thought of as replacing one oxygen atom after another. The properties of the resulting compounds differ in regular steps from one to the next. There exist, for example, compounds which contain all the members of the following series of complex ions:

AsO_4^{---}, AsO_3S^{---}, $AsO_2S_2^{---}$, $AsOS_3^{---}$ and AsS_4^{---}.

Sulfur-substituted compounds of this type are distinguished by the prefix *sulfo-* or *thio-*. Qualitative analysis makes large use of the reactions of the sulfur compounds of many elements.

Both oxides and sulfides are prominent among the mineral compounds in which most metals occur in the earth's crust. In analyzing minerals, the sulfides are usually oxidized by fusion with sodium peroxide or with a mixture of sodium carbonate and potassium nitrate. This puts them into the form of sulfates, which can be precipitated and weighed as barium sulfate.

The amount of oxygen in oxide minerals is traditionally not determined by chemical analysis. The metals present are determined and the quantity of oxygen necessary to form their most stable oxides is calculated.

In analyzing other types of compounds, specialized methods for determining the radicals and complexes likely to be present are available in

standard texts on organic and inorganic analysis.

Selenium and Tellurium

These rare analogues of sulfur are found in very small amounts in naturally-occurring minerals. Tellurium may be found by the spectroscope. To obtain selenium from a solution containing an appreciable amount, one recommended method involves its distillation with HBr, reduction of the distillate with a solution of SO_2 and separation of elemental Se with solid hydroxylamine hydrochloride.

Selenium is similar to sulfur in many of its properties. Like sulfur it occurs in allotropic forms. The form in which it is most like sulfur has a red color, but the other allotropic form of the element is gray. This is closer to tellurium, which has almost metallic qualities.

These two elements share with sulfur the ability to form compounds with unpleasant odors. Hydrogen sulfide smells like rotten eggs, because such eggs actually contain that compound. Selenium, when taken up by plants, is poisonous to animals. Therefore cabbage probably does not contain any selenium, but gaseous compounds of that element are said to smell like rotten cabbage. Similarly, compounds of tellurium smell like rotten radishes.

Polonium

Although this was the first radioactive element discovered by Marie and Pierre Curie, it has been rather obscured by the greater fame of radium. Its chemical properties threw it into the same class with bismuth in the Curies' analytical work. Even today, very little work has been done on its chemical nature, although it is known to be the heavier analogue of tellurium and to be even more metallic than that element, as would be expected. Minute traces only are found in radioactive minerals. Only among the fission products from atomic piles has enough polonium been found to make visible amounts of its compounds.

When identification of polonium is to be made, the analyst relies on its characteristic radiations.

Cause of Ivy Itch Sought

➤ Anyone having an itch to analyze olefinic compounds should find interesting work at Columbia University's department of chemistry where they are taking poison ivy to pieces to see what makes it so mean.

In common with Japanese lac and the liquid from the shells of the cashew nut, poison ivy extract contains several chemicals somewhat related to carbolic acid. Drs. W. F. Symes and C. R. Dawson at Columbia have found that the new method of chromatography allows them to separate these poisonous components and learn what each is made of.

In an experiment conducted in 1925, at the Cornell University Medical College a scientist stayed for two hours in dry air at a temperature of 201 degrees Fahrenheit and suffered no harm.

Chemical Knowledge Used For Latest Inventions

Patents on Chemical Devices

To obtain copies of patents, order by number from the Commissioner of Patents, Washington 25, D. C. Enclose 25 cents for each patent in coin, money order or Patent Office coupon (not stamps).

Exploding Aircraft

➤ AN EXPLODING aircraft has been patented which splits in half before "landing." The aircraft resembles a rocket. It has a charge of explosives nestled around its slender fuselage about midway between the nose and tail section.

Before the device begins its return to earth after a remote-controlled trip into the sky, the explosives are set off. This separates the nose from the tail. The tail falls away rapidly, but the nose sprouts a helicopter rotor which gently returns the instrument-carrying nose of the rocket to the earth.

The "severable aircraft" was invented by Roy J. Schmid of Camp Cooke, Calif., and received patent No. 2,654,320. The patent was issued under Title 35 of the U. S. patent laws, section 266. This permits the government to use the device without paying royalties to the inventor.

Electronographic Printing

➤ A NEW printing system has been worked out by William C. Huebner of New York City. Ink is transferred from the type to the paper by electromagnetic lines of force, rather than by pressure.

As paper starts through the high-speed printing press, a brush-like device sweeps off any electrical charge it may have. Then the paper is charged with a negative electric value. Ink on the cylinder just ahead of the paper is charged positively. As the paper passes beneath the rotating cylinder carrying the type, the ink jumps from the type to the paper because of the electrical attraction. Brushes again sweep off any electrical charge left on the paper before the next cylinder is reached.

Mr. Huebner, who assigned his patent, No. 2,654,315, to The Huebner Co., Dayton, Ohio, states that the system is designed to handle color printing as well as ordinary black-and-white printing.

Disintegrating Labels

➤ LEONARD R. NESTOR of St. Paul, Minn., has invented disintegrating labels for soft-drink and beer bottles so that the bottles can be more efficiently cleaned and refilled.

His label consists of water-resistant printable surface coating on a base sheet which comprises a mixture of aluminum particles and lightly bonded paper fibers. This label, he says, can withstand the wear and tear of ice-chest storage, but disintegrates quickly when passed through a warm five per cent caustic cleaning solution. The disintegrated labels are easily separated from the cleaning solution. Secret of the disintegrating label is that the bonding material which holds the fibers together dissolves in the caustic cleaning solution.

Mr. Nestor assigned his patent, No. 2,654,170, to the Minnesota Mining & Manufacturing Co. of St. Paul.

Ultrasonic Alarm

➤ A DEVICE that beams into a room sounds too high to be heard has been invented to give fire, burglar and damage warnings. Samuel M. Bagno of Astoria, N. Y., who assigned his patent, No. 2,655,645, to the Alertronic Corp. of New York, states that his invention detects any motion in a closed room. When fires break out, or if window panes are broken, the movement of air in the room is sufficient to trip the sensitive electronic device. Prowlers who run afoul of the silent sound waves also trigger the alarm.

Hermetically Sealed Glove

➤ EARL J. HOAGLAND of Chicago has invented a glove that effects a hermetic seal between the glove's rubber sleeve and the garment sleeve. The seal is designed to protect the arms and legs (when used with boots) against corrosive chemicals and gases which the worker must handle.

The wearer dons the gloves first, then puts on his jacket. A rubber liner on the garment sleeve fits over a stiffened rubber area on the glove's gauntlet, creating a surface contact of about 36 square inches which the inventor states is sufficient to insure complete protection against liquid and gas seepage. Mr. Hoagland assigned his patent, No. 2,656,663, to Standard Safety Equipment Co., Chicago.

Floating Oil Tank

➤ A FLOATING oil storage tank has been invented for off-shore drillers that is designed to get around operational and economical disadvantages of storing oil in barges until it is desired to take the oil ashore. The tank has adjustable buoyancy, permitting it to be completely submerged when necessary. Invented by Irwin W. Alcorn of Houston, Texas, the tank is protected by patent No. 2,655,888, which was assigned to The Pure Oil Co., Chicago.

Resistor-Printing Matrix

➤ PRINTED electronic circuits, growing in importance as a production technique, often must be impressed on plastic, ceramics, glass or other nonporous materials. Many methods of printing have been used to produce a resistor within allowable tolerances, two Washington, D. C., inventors state, but none have been able to yield the desired quantitative control of material.

Elise F. Harmon and Philip J. Franklin, who think they have an answer, worked out a cup-shaped matrix of polyethylene, teflon or similar non-wetting material. Although relatively firm, it still accommodates irregularities in ceramic surfaces. "Ink" is injected into the matrix under pressure through one hole, and air and excess ink are permitted to escape through another hole in the matrix. The dimensions of the ink wells can be varied, the inventors report, to obtain printed resistors of desired values. The patent, No. 2,656,570, was assigned to the Army.

Electromagnetic Pump

➤ THE ATOMIC Energy Commission now has another pump that should be useful in the handling of "hot" electrically conducting liquids, or those of extreme chemical activity. The centri-

fugal pump seizes liquids, such as alloys of sodium and potassium, with an invisible field, whirls them around inside the pump, then ejects them from a nozzle into the piping. Invented by Khatchik O. Donelian of Fairlawn, N. J., the electromagnetic pump received patent No. 2,658,452 and was assigned to the AEC. It can be licensed to American industry and used without royalty payments.

Jet Plane Launcher

➤ A BRITISH inventor has created a ground-based launching device for hurling jet airplanes into the air.

Barnes Neville Wallis of Weybridge, Eng., states his launcher eliminates the need for heavy assisted take-off equipment on the plane. Furthermore, should the plane's engine be defective "in any way" upon take-off, the craft can land within the limits of the airport.

The new device also promises to permit airports to devote one runway exclusively to taking-off planes, keeping one strip always open to landing planes. This, Mr. Wallis believes, will double the traffic capacity of many existing airports.

The launcher is a four-wheeled frame powered on rails by four jets. The airplane is mounted on a lever apparatus which holds the plane parallel to the earth and faces it into the wind.

As the plane's wings begin biting the air, the lifting force is transmitted to the lever. When the force is sustained for a given length of time, to assure that the plane will remain airborne, the plane is unlocked from the carriage and it roars into the sky under its own power.

Mr. Wallis' invention was granted patent No. 2,659,553 by the U. S. Patent Office. The inventor assigned his patent to Vickers-Armstrongs Ltd., of London.

Mechanical Heart and Lungs

➤ A MACHINE that may save many lives on the operating table won a patent for its four inventors. The machine is an "extra-corporeal circulation device" that takes the place of a patient's heart and lungs during delicate heart operations.

By providing a blood by-pass for the heart during difficult operations within the heart's chambers, the machine is designed to help the physician perform the operation with dispatch, with more ease and with more certainty of success.

Blood is taken from a vein and is circulated through the machine. The blood is oxygenated mechanically under controlled conditions, then is fed back into the patient's body.

Delicate instruments monitor the entire process and make certain that the blood remains at the proper temperature. If the machine "sucks" too hard so that the feeding vein collapses, as straws sometimes do in thick milkshakes, the machine automatically shuts down for an instant to correct the bad condition. It resumes a moment later when things again become normal.

The mechanical heart and lungs was invented by John H. Gibbon Jr. of Philadelphia, Pa., Gustav V. A. Malmros of Binghamton, John R. Engstrom of Endicott and Edmund A. Barber Jr. of Johnson City, N. Y. The inventors assigned their patent, No. 2,659,368, to the Jefferson Medical College of Philadelphia.

Proudly Presented

➤ THE RIGID but resillient property of Kel-F plastic pipe fittings and the inert nature of this trifluorochloroethylene polymer are being put to good use in infrared gas analyzers manufactured by Leeds & Northrup Co. in both standard and "explosion-proof" models. Information on how this pipe-line material fits into other chemical processes may be obtained from the M. W. Kellogg Co. by writing their Technical Service, Chemical Manufacturing Division, P. O. Box 469, Jersey City 3, N. J.

➤ BLAW-KNOX announces their contract with the Anderson-Prichard Oil Corporation of Oklahoma City to build a catalytic reforming plant which will increase their yield of premium quality gasoline. The plant is to be completed early in 1954.

➤ SELECTION of radiation detection equipment is simplified by use of Catalog No. 15 issued by Radiation Counter Laboratories, 5122 West Grove St., Skokie, Ill. The catalogue is divided into sections describing electronic equipment, radiation counter tubes and glass apparatus.

➤ SIX KINDS of uses for glycerine are explained from the standpoint of the formulator's problem and how it was met by use of that chemical. A new booklet giving this information is available by writing the Glycerine Producers' Association, 295 Madison Ave., New York 17, N. Y.

➤ FREEZE-DRYING is a new technique finding use in food, pharmaceutical and biological products preparation. Explanation of typical process problems is included in Catalog No. 735 issued by the F. J. Stokes Machine Co., 5500 Tabor Road, Philadelphia 20, Pa., which makes the machinery for this process.

➤ PARLON is the trade-mark name for chlorinated natural rubber as produced by the Hercules Powder Co., Wilmington 99, Del. A booklet is available from them describing its use in protective coatings, for many kinds of corrosive environments.

➤ PHOTOGRAPHIC Plates for Scientific and Technical Use are described in the new seventh edition of Eastman Kodak Co.'s data book. It will be sold by Kodak dealers for 50 cents.

➤ CONSULTING service in combustion and flame phenomena, ignition systems, explosives, hazard prevention and safety are offered by a group of scientists and engineers organized as Combustion and Explosives Research, Alcoa Building, Pittsburgh 19.